IN THE CLAIMS:

1. (Cancelled)

2. (Previously Presented) The manufacturing method of an arc tube of Claim 20, wherein

the glass tube being substantially straight is heated so that a temperature of a double spiral scheduled portion is within a range between a softening point of the glass tube and 150 degrees centigrade over the softening point inclusive, the double spiral scheduled portion being such a portion of the glass tube that is to be formed into the double spiral.

3. (Previously Presented) The manufacturing method of an arc tube of Claim 20, wherein

the glass tube being substantially straight is heated so that a temperature of a double spiral scheduled portion varies in a lengthwise direction within a range of ±8 degrees centigrade of a heating target temperature inclusive, the double spiral scheduled portion being such a portion of the glass tube that is to be formed into the double spiral.

4. (Previously Presented) The manufacturing method of an arc tube of Claim 20, wherein

the mandrel is disposed beneath a substantially center of a double spiral scheduled portion, which is such a portion of the glass tube that is to be formed into the double spiral, and

an axis of the mandrel extends substantially perpendicularly.

5. (Previously Presented) The manufacturing method of an arc tube of Claim 20, wherein

the glass tube, being substantially straight, is held by ends thereof so that a tube axis of the glass tube is substantially horizontal.

6. (Previously Presented) The manufacturing method of an arc tube of Claim 20, wherein

while the glass tube is substantially perpendicularly lowered, a portion in a vicinity of a center of a double spiral scheduled portion sags downward, the double spiral scheduled portion being such a portion of the glass tube that is to be formed into the double spiral.

7. (Previously Presented) The manufacturing method of an arc tube of Claim 20, wherein

a double spiral scheduled portion, which is such a portion of the glass tube that is to be formed into the double spiral, is positioned parallel with the winding grooves when viewed from a direction orthogonal to an axis of the mandrel, before the double spiral scheduled portion is wound along the winding grooves.

8. (Currently Amended) The manufacturing method of an arc tube in which a glass tube is formed into a double spiral by being wound around a mandrel, the manufacturing method comprising:

a holding step of holding ends of the glass tube by movable chuck units;

a softening step of softening the glass tube held by the chuck units by applying heat to the glass tube in a heating furnace;

a moving step of moving the glass tube being in a soft state substantially perpendicularly downward from an exit of the heating furnace to the mandrel positioned below the exit of the heating furnace;

a hanging and holding step of ~~lowering the softened glass tube substantially perpendicularly from the heating furnace so that the softened glass tube is hung with a part thereof being held~~ hanging and holding the moved glass tube being in a soft state on a top of the mandrel positioned below the heating furnace; and

a winding step of winding a remaining part of the softened glass tube around the mandrel[[,]]. ~~wherein~~

~~the mandrel has, on a periphery thereof, winding grooves that correspond to the double spiral,~~

~~a double spiral scheduled portion, which is such a portion of the glass tube that is to be formed into the double spiral, is positioned parallel with the winding grooves when viewed from a direction orthogonal to an axis of the mandrel, before the double spiral scheduled portion is wound along the winding grooves,~~

~~ends of the glass tube are held by chuck units, and~~

~~the double spiral scheduled portion is positioned parallel with the winding grooves by moving the chuck units in a direction that make the chuck units farther apart from each other, along a line that connects one of the chuck units with the other of the chuck units when viewed from a direction toward which an axis of the mandrel extends.~~

9. (Original) The manufacturing method of an arc tube of Claim 2, wherein

at least one pair of supporting rollers for supporting the double spiral scheduled portion is provided in a vicinity of the mandrel, and

the glass tube being in a soft state is substantially perpendicularly lowered so that the glass tube is disposed across the pair of supporting rollers.

10. (Previously Presented) The manufacturing method of an arc tube of Claim 7 wherein

ends of the glass tube being in a soft state are held by chuck units which each move toward the mandrel as the glass tube is wound around the mandrel, and

a first speed at which the glass tube is wound around the mandrel in the winding step is higher than a second speed at which the chuck units move.

11. (Cancelled)

12. (Previously Presented) The manufacturing method of an arc tube of Claim 20, wherein

the glass tube being in a soft state is guided into winding grooves of the mandrel by a pair of guiding rollers provided in a vicinity of the mandrel.

13. (Original) The manufacturing method of an arc tube of Claim 12, wherein

the pair of guiding rollers is positioned so that an axis of each guiding roller is inclined at an angle of

$\pi/2-\alpha$ to an axis of the mandrel, where α is an angle at which each of the winding grooves is inclined to the axis of the mandrel.

14. (Original) The manufacturing method of an arc tube of Claim 10, wherein

the glass tube being in the soft state is guided into winding grooves of the mandrel by a pair of guiding rollers provided in a vicinity of the mandrel.

15. (Original) The manufacturing method of an arc tube of Claim 14, wherein

the pair of guiding rollers is positioned so that an axis of each guiding roller is inclined at an angle of

$\pi/2-\alpha$ to an axis of the mandrel, where α is an angle at which each of the winding grooves is inclined to the axis of the mandrel.

16. (Previously Presented) The manufacturing method of an arc tube of Claim 20, wherein

while the glass tube is wound in the winding step, a gas for inflating the gas tube is sent into the glass tube being hung and held on the top of the mandrel, and

when the glass tube finishes being wound, a gas for cooling down the glass tube is sent into the glass tube.

17. - 19. (Cancelled)

20. (Previously Presented) A manufacturing method of an arc tube in which a glass tube is formed into a double spiral by winding around a mandrel comprising the steps of;

providing a predetermined length of an elongated straight glass tube;

supporting the respective end portions of the glass tube with an intermediate portion of the glass tube unsupported;

heating the glass tube in a heating furnace and softening the intermediate portion of the glass tube to sag;

lowering the heated glass tube until the sagging intermediate portion engages the mandrel with grooves representative of the double spiral configuration, the mandrel being disposed beneath the heating furnace and the sagging intermediate portion of the glass tube;

winding the heated glass tube about the mandrel to provide the double spiral configuration; and

removing the glass tube formed in the double spiral configuration from the mandrel.

21. (Previously Presented) The manufacturing method of an arc tube of Claim 20 further comprising applying a tension force to the intermediate portion of the glass tube to maintain a constant glass tube diameter when the heated glass tube is being wound about the mandrel.

22. (Previously Presented) The manufacturing method of an arc tube of Claim 21 wherein the tension force is applied by aligning the end portion of the glass tube with an angle of

a spiral part of the double spiral configuration and maintaining a ratio of a moving speed of the end portions toward the mandrel to a winding speed of the mandrel from 0.6 to less than 1.0.

23. (Previously Presented) The manufacturing method of an arc tube of Claim 20 further comprising applying a gas pressure into the glass tube when the heated glass tube is being wound about the mandrel.

24. (New) The manufacturing method of an arc tube of Claim 8, wherein

the mandrel has, on a periphery thereof, winding grooves that correspond to the double spiral,

a double spiral scheduled portion, which is such a portion of the glass tube that is to be formed into the double spiral, is positioned parallel with the winding grooves when viewed from a direction orthogonal to an axis of the mandrel, before the double spiral scheduled portion is wound along the winding grooves, and

the double spiral scheduled portion is positioned parallel with the winding grooves by moving the chuck units in a direction that make the chuck units farther apart from each other, along a line that connects one of the chuck units with the other of the chuck units when viewed from a direction toward which an axis of the mandrel extends.

25. (New) The manufacturing method of an arc tube of Claim 24, wherein

the ends of the glass tube being in the soft state are held by chuck units which each move toward the mandrel as the glass tube is wound around the mandrel, and

a first speed at which the glass tube is wound around the mandrel in the winding step is higher than a second speed at which the chuck units move.

26. (New) The manufacturing method of an arc tube of Claim 25, wherein

a ratio of the second speed to the first speed is between 0.6 and 1.0.

27. (New) The manufacturing method of an arc tube of Claim 26, wherein

while the glass tube is wound in the winding step, a gas for inflating the gas tube is sent into the glass tube being hung and held on the top of the mandrel, and

when the glass tube finishes being wound, a gas for cooling down the glass tube is sent into the glass tube.

28. (New) The manufacturing method of an arc tube of Claim 8, wherein in the softening step, the glass tube is held by the chuck units and an intermediate portion of the glass tube sags in a gravitational direction from a gravitational force and the mandrel is positioned directly below the exit of the furnace in alignment with the gravitational direction.

29. (New) A system for manufacturing an arc tube comprising:

means for holding ends of a glass tube;

means for heating and softening the glass tube such that an unsupported central portion of the glass tube is substantially linear when the glass tube traverses a substantially horizontal direction, and the unsupported central portion of the glass tube is in a soft state sagging in a gravitational direction due to a gravitational force while the ends of the glass tube

remain substantially linear when the glass tube traverses a substantially vertical direction prior to the glass tube exiting an exit of the means for heating and softening the glass tube;

means for moving the glass tube while the unsupported central portion of the glass tube is in the soft state in the gravitational direction from the exit of the means for heating and softening the glass tube to a mandrel located beneath the exit of the means for heating and softening the glass tube and positioned in alignment with the gravitational direction;

means for hanging and holding the glass tube on a top of the mandrel located beneath the exit of the means for heating and softening the glass tube and positioned in alignment with the gravitational direction while the unsupported central portion of the glass tube is in the soft state;

means for pumping gas into the glass tube through the ends of the glass tube;

means for winding the glass tube around the mandrel while the unsupported central portion of the glass tube is in the soft state; and

means for providing a tension load on the glass tube through the ends of the glass tube when the mandrel starts to rotate.